phenol which separate on cooling are removed. After exposing the residue for some time over sulphuric acid, a crystalline mass is obtained, which is pressed, and recrystallized from boiling water or from alcohol. Pure saligenin is thus obtained.

The quantity of saligenin is by no means in proportion to the quantity of phenol employed, and an alcoholic solution of sodium hydrate was found to yield no better results than an aqueous solution, although the reaction took place more promptly.

Isomeric oxybenzylic alcohols may be, and probably are, formed at the same time, but I have not yet been able to isolate such compounds.

On the Foramina Perforating the Posterior Part of the Squamosal Bone of the Mammalia. *By E. D. Cope.*

(*Read before the American Philosophical Society, February* 6, 1880.)

The number of perforations of the posterior part of the squamosal bone in the *Mammalia* is considerable, and they have not attracted that attention from anatomists which their importance deserves. As I have found them to be especially valuable in diagnosis, I have thought it might be useful to place on record the manner of their occurrence in various recent genera with whose structure we are more or less familiar in other respects.

The one of these foramina of which some notice has been taken, is the *postglenoid*, which is mentioned by Flower (Osteology of Mammalia) as occurring in the dog and bear, and as absent in the cat. I find five other foramina which usually form the outlets of canals which are connected with the lateral venous sinus. The principal canal extends from the postglenoid foramen upwards and backwards between the os petrosum and the squamosal, and enters the cranial cavity at the superior border of the former. At a point in the parietal bone, often on or very near the squamoso-parietal suture, it issues on the surface again, in the foramen which may be called the *postparietal*. A branch of the canal may take a posterior direction and issue on the occipital face of the skull in the suture between the *ossa petrosum* and *exoccipitale*, forming the *mastoid* foramen. Or a posterior branch may issue in the posterior part of the squamosal bone in a lateral foramen, the *postsquamosal*. In certain Mammals a large foramen perforates the base of the zygomatic process of the squamosal from above, entering the canal after a short course of its own; this I call the *supraglenoid* foramen. Still another inlet to the canal is found in some Mammals, perforating the squamosal below the crest which connects the zygoma with the inion, occupying a position posterior and exterior to the post-

glenoid, and generally looking more downwards than outwards. I call this the *subsquamosal*. These foramina may be arranged in four sets, as follows :

I. Looking downwards ;
Postglenoid.
Subsquamosal.
II. Looking outwards ;
Postsquamosal.
Postparietal.
III. Looking upwards ;
Supraglenoid.
IV. Looking backwards ;
Mastoid.

Some foramina of the same region are not necessarily connected with the *sinus lateralis*. Hyrtl, in his essay* on the arterial system of the *Edentata*, shows that a foramen near to the postsquamosal of the *Tamandua tetradactyla*, gives passage to an "*arteria diploëtica*," which is formed by the junction of the occipital branch of the carotid with an ascending branch of the *temporo-maxillaris* division of the carotid. The *a. diploëtica* issues in a foramen which perforates the parietal bone on the orbital border. These two foramina may be called the *f. diploëticum posterior* and *f. d. anterior*, respectively. The former enters from the fundus of the same small fossa, which is also perforated in its superior portion by the *f. postsquamosale*, the canal from the latter foramen taking the usual vertical direction.

Still another foramen exists, which is, so far as my present knowledge goes, confined to the *Monotremata* and *Marsupialia*. It enters the posterior base of the zygomatic portion of the squamosal, and is directed forwards.

In *Tachyglossus* it passes through the base of the zygoma, issuing in the base of the zygomatic fossa. In the *Marsupialia* it enters a fossa of the squamosal bone, which may or may not be partially filled with cancellous tissue. I call this the *foramen postzygomaticum*.

I now give the results of my observations on the crania of the most important genera which I have observed, one hundred and sixteen in number.†

Monotremata.

Tachyglossus. The only foramina are the *f.f. diploëtica anterior* and *posterior*, and the *postzygomaticum*. The anterior half of the canal connecting the former two has no external wall.

Ornithorhynchus. Postzygomatic large and passing through the zygoma ; postsquamosal large ; no other foramina.

Marsupialia.

The types of this order generally have the postglenoid, and hardly ever have the supraglenoid or postparietal. They are generally distinguished

* Denkschriften Wiener Akademie, 1851, T. III, pl. 1.

† Most of these are preserved in my private collection ; for a few I am indebted to the Museum of the Philadelphia Academy.

by the presence of the subsquamosal, but in *Hypsiprymnus* and *Macropus* this foramen becomes the postsquamosal, through the failure of the postzygomatic crest. It need not be confounded with another foramen also found in these genera, which enters above the *meatus auditorius externus*, and communicates with the tympanic chamber, and which I call the *supratympanic foramen*. The subsquamosal enters the sinous canal, and in *Phascolarctos*, where the postglenoid is wanting, constitutes its only external outlet. The order is further characterized by the presence of the postzygomatic foramen.

Phascolomys; postzygomatic chamber enormous, extending above meatus. No foramina below, except supratympanic; above, a supraglenoid and one or two postglenoids.

Phascolarctos; subsquamosal and postzygomatic only; the latter communicating with an empty chamber.

Macropus and *Hypsiprymnus;* postglenoid, postzygomatic, supratympanic and postsquamosal; the second communicating with a chamber filled with cancelli.

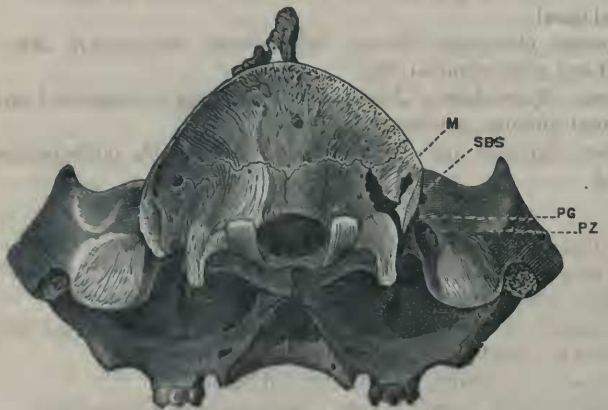

FIG. 1.—Skull of opossum (*Didelphys virginiana*) natural size, posterior view, parts of the right mastoid and squamosal bones removed. M, mastoid foramen; SBS, subsquamosal; PG, postglenoid; PZ, postzygomatic foramen.

Didelphys; postglenoid, postzygomatic, subsquamosal and mastoid; postzygomatic small.

Dasyurus; postglenoid, subsquamosal and probably mastoid. I cannot find a postzygomatic.

Phalangista; postsquamosal and postparietal only; no postzygomatic nor supratympanic.

EDENTATA.

Tamandua; F. f. diplöetica anterior and *posterior*, and postsquamosal only.

Dasypus (6-*cinctus*); postglenoid (large), postsquamosal, mastoid, several postparietals, and a small subsquamosal.

Chlamydophorus ; a postglenoid only.

Manis ; postzygomatic only.

Megalonyx ; postsquamosal and supratympanic ; a closed fissure at position of postglenoid. A large foramen below the usual position of mastoid.

Bradypus and *Cholœpus ;* no foramina.

Rodentia.

In this order, so far as yet observed, the supraglenoid and postparietal foramina are never present, while the mastoid is rarely, and the subsquamosal is generally, represented. The ridge connecting the zygoma with the inion being weak, the difference between this foramen and the postsquamosal is less marked in this order than in the *Marsupialia.* It is, however, always on the inferior border of the squamosal bone.

Lepus and *Lagomys ;* no foramina.

Lagidium ; no foramina.

Cercolabes ; no foramina.

Lagostomus, Geomys and *Erithizon ;* an enormous postglenoid without internal canal.

Capromys, Cœlogenys, Sciurus, Haplodontia, Hesperomys, Mus ; postglenoid and postsquamosal only.

Hystrix, Hydrochœrus, Neotoma and *Arvicola ;* postglenoid and postsquamosal foramina confluent ; no others.

Castor, Cynomys and *Spermophilus ;* postglenoid, postsquamosal and mastoid.

Insectivora.

The foramina are very much as in the *Rodentia* in the smaller forms, and as in the *Carnivora* in the larger.

Blarina, Condylura and *Scalops ;* postsquamosal only.

Erinaceus ; postglenoid and postsquamosal only. *Mystomys* the same, according to Allman's figures.

Centetes ; postglenoid, postparietal and mastoid.

Solenodon (from Peters' figures) ; postglenoid and postparietal.

Chiroptera.

In some members of this order the foramina are, as in many Carnivora, limited to the postglenoid and postparietal.

Scotophilus (*fuscus*) ; postglenoid, postparietal and mastoid.

Pteropus ; postglenoid, subsquamosal and postsquamosal.

Carnivora.

In this order the foramina are few in number, and are very well defined. None of them possess more than three, while the specialized forms, both terrestrial and aquatic, do not possess them.

Trichecus and *Arctocephalus ;* no foramina.

Phoca ; a rudimental postglenoid.

Ursus, *Arctotherium* and *Hyænodon*; postglenoid, mastoid and postparietal.

Enhydrocyon and *Temnocyon*; postglenoid and postparietal only.

FIG. 2.—*Temnocyon coryphæus* Cope, Lower Miocene of Oregon; one-half natural size. PP, postparietal foramen.

Archælurus, *Dinictis*, *Pogonodon*, *Hoplophoneus* and *Machærodus* (*cerebralis*); postglenoid and postparietal only.

Procyon, *Nasua* and *Bassaris*; postglenoid only.

Canis, *Vulpes* and *Urocyon*; postglenoid only.

Viverra, *Mustela*, *Putorius* and *Mephitis*; postglenoid only.

Felis (*domestica*); sometimes a minute postglenoid only; sometimes none.

Hyæna, *Uncia*, *Cynælurus*; no foramina.

PROSIMIÆ.

Lemur, *Chirogaleus* and *Tarsius*; a postglenoid only.

QUADRUMANA.

Hapale; postglenoid and postsquamosal.

Cebus; postglenoid and postparietal. The latter is on the suture of the parietal and squamosal bones; in *Hapale penicillata* it is entirely within the squamosal bones.

Ateles, *Callithrix*, *Myceles*, *Semnopithecus* and *Cynocephalus*; no foramina.

Macacus; a small postglenoid.

Troglodytes niger, *gorilla*; a closed fissure, but no foramen postglenoideum.

Homo; no foramina in sixteen North American Indians examined of the Klamath, Bannock, Crow, Sioux and Cheyenne tribes. One postglenoid on one side in a South Australian. One or two mastoids are more usual, being found in a good many specimens of all races. They are rarest in Hottentot negroes.

CETACEA.

Balæna, *Beluga* and *Monodon*; no foramina.

SIRENIA.

Halicore and *Manatus*; a huge mastoid only.

HYRACOIDEA.

Hyrax; no foramina.

PROBOSCIDIA.

Elephas; no foramina.

PERISSODACTYLA.

In this order the number of the foramina ranges from very few to many.

FIG. 3.—*Aphelops megalodus* Cope, Loup Fork of Colorado; one-sixth natural size, showing postparietal foramen.

Rhinocerus, Aphelops; postparietal only.

FIG. 4.

FIG. 5.

Skulls of *Aphelops megalodus* (Fig. 4) and *A. fossiger* (Fig. 5) from behind; one-sixth natural size; showing absence of mastoid foramen.

Tapirus; postparietal and a huge mastoid.

Anchitherium, Hippotherium, Protohippus and *Equus;* postparietal, postsquamosal, postglenoid and supraglenoid. In the last three genera

the vessel issuing from the postsquamosal, grooves the petrous bone, leaving it at a point near that usually occupied by the mastoid foramen. In the second and last genera, and probably in the third, the sinous canal is protected by a bony crest in front, throughout its entire length.

Artiodactyla.

Great diversities are found in this order, especially between the suilline and ruminant divisions. In the former, with the exception of the *Hippopotamidæ*, there are no foramina; in the *Ruminantia* they are more numerous than in any other order of the class. The *Ruminantia* are, like the equine *Perissodactyla*, characterized by the presence of the supraglenoid foramen; to this the *Camelidæ* and some others add the mastoid. The *Tragulina* must be excepted from this rule, for they have nothing but the postglenoid.

Omnivora.

Sus, *Dicotyles* and *Phacochœrus;* no foramina.

Hippopotamus and *Chœropsis;* postglenoid, postsquamosal, mastoid and a rudimental supraglenoid.

Ruminantia.

Tragulus; postglenoid only.

Oreodon; postparietal and mastoid. In one specimen of *O. culbertsoni* from Colorado, I find a minute supraglenoid on each side; in other specimens it is wanting.

Poëbrotherium; postparietal, postglenoid; mastoid; a small supraglenoid.

Fig. 6.—Skull of *Procamelus occidentalis* Leidy, Loup Fork of New Mexico; one-fourth natural size; showing supraglenoid foramen, SPG.

Procamelus, *Camelus*, *Auchenia;* postglenoid, supraglenoid and mastoid.

Bos; postglenoid and supraglenoid only.

Antilocapra; postparietal, postglenoid, mastoid, and a large supraglenoid.

Giraffa; postglenoid, supraglenoid, postsquamosal and mastoid.

Oreas, *Ovis*, *Cervus:* postglenoid, supraglenoid, postsquamosal, postparietal and mastoid.

From the preceding the following conclusions may be derived :

(1) The sinous foramina furnish valuable diagnostic characters, and may, with proper limitation, be used in systematic definition.

(2) The primitive condition of the various mammalian orders appears to have been the possession of a limited number of these foramina.

(3) The monotreme-marsupial line have developed a number of foramina in their own special way.

(4) The *Rodentia* have chiefly developed those of the inferior part of the squamosal bone, if any.

(5) The *Carnivora* commenced with but few foramina, and have obliterated these on attaining their highest development.

(6) The history of the *Quadrumana* is identical with that of the *Carnivora*.

(7) The *Perissodactyla* present very few foramina in the lowest forms, and did not increase them in the line of the *Rhinocerida*. In the line of the horses an increase in their number appeared early in geologic time, and is fully maintained in the existing species.

(8) In the Omnivorous division of the *Artiodactyla*, time has obliterated all the sinous foramina. In the Camels an increased number was apparent at the same geologic period as in the history of the horses (White River or Lowest Miocene), and has been maintained ever since ; while the existing *Pecora* present a larger number of the foramina than any of the class of *Mammalia*.

The only relation between these structures and the habits of the species concerned that can now be traced is, that the largest number of the foramina is found in the specialized vegetable feeders, while the smallest number is found in omnivorous forms.

I now give a synopsis of the distribution of the sinous foramina according to the foramina themselves. The *f. f. diploëtica*, *postzygomatica* and *supratympanicum* are not included, as their existence is restricted to the few types already mentioned.

I. No foramina.

Homo, Troglodytes, Cynocephalus, Semnopithecus, Mycetes, Callithrix, Ateles.

Uncia, Hyæna, Arctocephalus, Trichecus.

Elephas, Hyrax ;

Sus, Phacochœrus, Dicotyles.

Lepus, Lagidium, Cercolabes.

Cholœpus, Bradypus.

II. Postglenoid only.

a. Rudimental.

Felis ; Phoca.

aa. Developed.

Chlamydophorus.

Lemur, Chirogaleus, Tarsius ;

Macacus.

Mustela, Putorius, Mephitis; Canis. Vulpes, Urocyon; Viverra. Procyon, Nasua, Bassaris.
Tragulus.

aaa. Enormous.
Lagostomus and *Geomys.*

III. Subsquamosal only.
Phascolarctos.

IV. Postsquamosal only.
Ornithorhyncus, Tamandua, Blarina, Condylura, Scalops.

V. Postparietal only.
Rhinocerus, Aphelops.

VI. Mastoid only.
Halicore, Manatus.

VII. Postglenoid and subsquamosal only.
Hystrix, Hydrochœrus, Capromys, Cœlogenys, Sciurus, Haplodontia, Neotoma, Hesperomys, Mus, Arvicola.

VIII. Postglenoid and postsquamosal only.
Erinaceus.
Macropus, Hypsiprymnus.
Hapale.

IX. Postglenoid and postparietal.
Chiroptera sp.
Temnocyon, Enhydrocyon;
Archælurus, Dinictis, Pogonodon, Hoplophoneus, Machærodus.
Cebus.

X. Mastoid and postparietal.

a. Mastoid small.
Oreodon.

aa. Mastoid enormous.
Tapirus.

XI. Mastoid, postglenoid and postsquamosal.
Castor, Cynomys, Spermophilus.

XII. Mastoid, postglenoid and subsquamosal.
Dasyurus, Didelphys.

XIII. Mastoid, postglenoid and postparietal.
Scotophilus (fuscus).
Centetes.
Hyænodon, Ursus, Arctotherium;

XIV. Supraglenoid and postsquamosal only.
Phascolomys.

XV. Supraglenoid and postglenoid only.
Bos.

XVI. Supraglenoid, postglenoid and mastoid.
Procamelus, Camelus, Auchenia.

XVII. Supraglenoid, postglenoid, mastoid, postparietal.

a. Supraglenoid small.
Poëbrotherium.

aa. Supraglenoid large.
Antilocapra.

XVIII. Supraglenoid, postglenoid, mastoid and postsquamosal.

a. Supraglenoid small.
Hippopotamus, Chœropsis.

aa. Supraglenoid large.
Giraffa.

XIX. Supraglenoid, postglenoid, postparietal and postsquamosal.

a. Supraglenoid small; mastoid not grooved.
Anchitherium.

β. Supraglenoid large, mastoid grooved.
Hippotherium, Protohippus, Equus.

XX. Supraglenoid, postglenoid, postparietal, postsquamosal and mastoid.
Cervus, Oreas, Ovis.

Biographical Notice of Professor Joseph Henry. By Fairman Rogers.

(*Read before the American Philosophical Society, February* 20, 1880.)

The admirable memoir of Prof. Joseph Henry, prepared by Mr. William B. Taylor, and read before the Philosophical Society of Washington, October 26, 1878, is so exhaustive both as to his scientific labors and the incidents of his life that little can be added to it until at some future time a biographer will undertake the preparation of a more voluminous life and letters.

As to his scientific career, the memoir deals principally with his earlier work as being more directly personal, and the results of his own manipulation and experiment, while his later days were devoted to the direction and coördination of the work of others.

Regret has frequently been expressed by the scientific friends of Prof. Henry, that his acceptance of the Secretaryship of the Smithsonian, and his devotion to the interests of that Institution had withdrawn him from those lines of original research, in which he shone so conspicuously, and while these regrets are perhaps well-founded, it is a question whether he could possibly have been of more value to science under any circumstances other than those in which this later part of his life was passed.

In his position his influence upon American Science was great and varied. He was a constant and shining example before the eyes of the younger scientific men of an unselfish devotion to the interests of science for itself, and not for self aggrandizement. Honest in the widest and deepest sense of the word, he never permitted expediency, self-interest or passion to interfere with the search for truth, and his clear and simple expressions on such subjects put it out of the power of those who consulted him to do otherwise than follow the example which he set them.